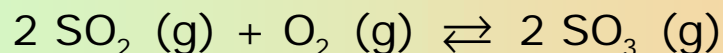


Exercises: Kc

Exercise #01

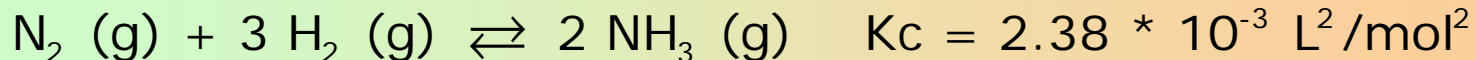
In a 2 L-container 4.0 g sulfur dioxide, 4.0 g oxygen and 20 g sulfur trioxide are at equilibrium. Determine the equilibrium constant Kc at that temperature for this reaction :



Atomic Weights: S=32; O=16

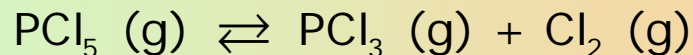
Exercise #02

At 1000 K 1.03 mol/L nitrogen, 1.62 mol/L hydrogen and some amount of ammonia are at equilibrium. Determine the concentration of ammonia in this container, given the following data :



Exercise #03

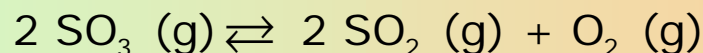
In a 10 L-container the initial composition is 1 mol of phosphorus pentachloride. At a certain temperature, when the equilibrium is reached, only 0.3 mol of that compound is present. Determine the equilibrium constant for this reaction:



Exercises: Kc

Exercise #04

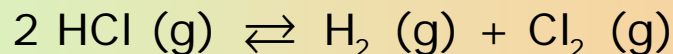
A 1-L vessel is charged initially with 80 g of sulfur trioxide. When equilibrium is reached at a certain temperature 0.6 mol of SO₂ are found inside. Determine the equilibrium constant, K_c, for this equation:



Atomic Weights: **S=32; O=16**

Exercise #05

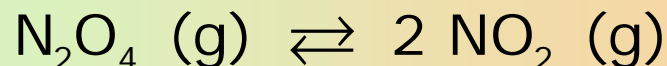
An initial composition in a 10 L-container is 104.39 g of hydrogen chloride and 2.00 g of hydrogen. When the equilibrium is reached, 1.30 mol of HCl are in the container. Determine the equilibrium constant for this reaction :



M (HCl) = 36.5 g/mol; M(H₂) = 2 g/mol

Exercise #06

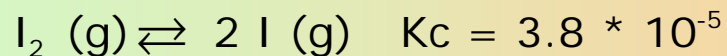
A 2 L-flask is charged with 0.10 mol of N₂O₄ and the equilibrium described below is reached. At this temperature the equilibrium constant is 0.58 mol/L. Determine the concentrations at equilibrium.



Exercises: Kc

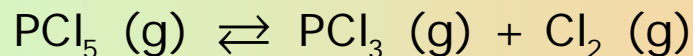
Exercise #07

A 2.3 L-container is initially charged with 0.0456 mol I_2 . Determine the concentrations of both components at equilibrium if temperature is kept constant.



Exercise #08

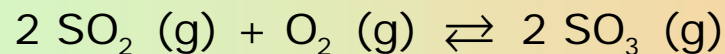
At a certain temperature, the equilibrium constant K_c for the reaction below is 0.00793 mol/L. Determine the percentage of decomposition of PCl_5 at the same temperature if a 1 L-flask is charged initially 3.13 mol of PCl_5 .



Exercises: Kc

Exercise #01

In a 2 L-container 4.0 g sulfur dioxide, 4.0 g oxygen and 20 g sulfur trioxide are at equilibrium. Determine the equilibrium constant Kc at that temperature for this reaction :



Atomic Weights: S=32; O=16

The concentrations at equilibrium:

$$[\text{SO}_3] = \frac{n (\text{SO}_3)}{V} = \frac{20 \text{ g}}{2 \text{ L}} \frac{1 \text{ mol}}{80 \text{ g}} = 0.125 \text{ M SO}_3$$

$$[\text{SO}_2] = \frac{n (\text{SO}_2)}{V} = \frac{4 \text{ g}}{2 \text{ L}} \frac{1 \text{ mol}}{64 \text{ g}} = 0.03125 \text{ M SO}_2$$

$$[\text{O}_2] = \frac{n (\text{O}_2)}{V} = \frac{4 \text{ g}}{2 \text{ L}} \frac{1 \text{ mol}}{32 \text{ g}} = 0.0625 \text{ M O}_2$$

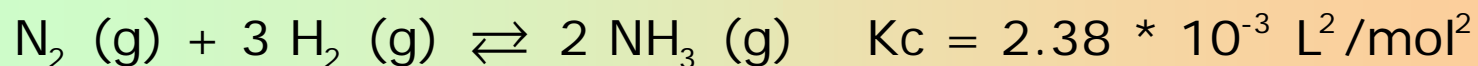
The value of Kc:

$$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 [\text{O}_2]} = \frac{(0.125 \text{ M})^2}{(0.03125)^2 (0.0625)} = 256 \frac{\text{L}}{\text{mol}}$$

Exercises: Kc

Exercise #02

At 1000 K 1.03 mol/L nitrogen, 1.62 mol/L hydrogen and some amount of ammonia are at equilibrium. Determine the concentration of ammonia in this container, given the following data :



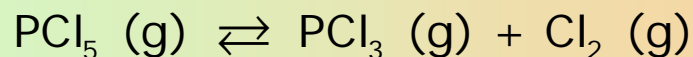
Substituting the values:

$$K_c = 2.38 * 10^{-3} = \frac{[\text{NH}_3]^2}{[\text{H}_2] [\text{N}_2]^3}$$
$$2.38 * 10^{-3} = \frac{[\text{NH}_3]^2}{(1.03 \text{ M}) (1.62 \text{ M})^3}$$
$$[\text{NH}_3] = 0.102 \text{ M}$$

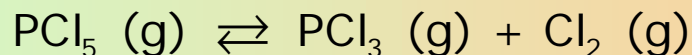
Exercises: Kc

Exercise #03

In a 10 L-container the initial composition is 1 mol of phosphorus pentachloride. At a certain temperature, when the equilibrium is reached, only 0.3 mol of that compound is present. Determine the equilibrium constant for this reaction:



The # of moles and concentrations at equilibrium:



n initial	1	0	0
n changes	-x	x	x
n equilibrium	1-x = 0.3	x = 0.7	x = 0.7
[] equilibrium	0.03 M	0.07 M	0.07 M

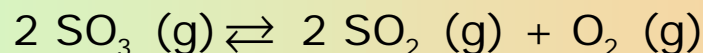
The equilibrium constant is:

$$K_c = \frac{[\text{PCl}_3] [\text{Cl}_2]}{[\text{PCl}_5]} = \frac{(0.07)^2}{(0.03)} = 0.163$$

Exercises: Kc

Exercise #04

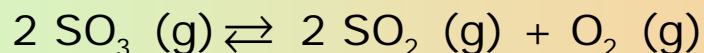
A 1-L vessel is charged initially with 80 g of sulfur trioxide. When equilibrium is reached at a certain temperature 0.6 mol of SO₂ are found inside. Determine the equilibrium constant, K_c, for this equation:



Atomic Weights: **S=32; O=16**

Molar mass of SO₃: $M(\text{SO}_3) = 32 + (3 \cdot 16) = 80 \text{ g/mol}$

The # of moles and concentrations at equilibrium:



n initial	1	0	0
n changes	-2x	2x	x
n equilibrium	1-2x = 0.4	2x = 0.6	x = 0.3
[] equilibrium	0.4 M	0.6 M	0.3 M

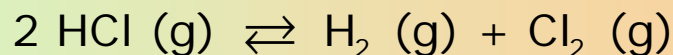
The equilibrium constant is:

$$K_c = \frac{[\text{SO}_2]^2 [\text{O}_2]}{[\text{SO}_3]^2} = \frac{(0.6)^2 (0.3)}{(0.4)^2} = 0.675$$

Exercises: Kc

Exercise #05

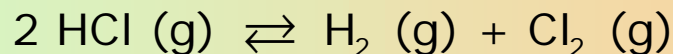
A initial composition in a 10 L-container is 104.39 g of hydrogen chloride and 2.00 g of hydrogen. When the equilibrium is reached, 1.30 mol of HCl are in the container. Determine the equilibrium constant for this reaction :



$M(\text{HCl}) = 36.5 \text{ g/mol}$; $M(\text{H}_2) = 2 \text{ g/mol}$

Initial n: $n(\text{HCl}) = \frac{104.39 \text{ g}}{36.5 \text{ g/mol}} = 2.86 \text{ mol HCl}$; $n(\text{H}_2) = 1 \text{ mol H}_2$

The # of moles and concentrations at equilibrium:



n initial	2.86	1	0
n changes	-2x	x	x
n equilibrium	2.86-2x = 1.30	1+x = 1.78	x = 0.78
[] equilibrium	0.13 M	0.178 M	0.078 M

$$x=0.78$$

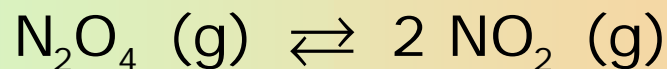
The equilibrium constant is:

$$K_C = \frac{[\text{H}_2] [\text{Cl}_2]}{[\text{HCl}]^2} = \frac{(0.178) (0.078)}{(0.13)^2} = 0.82$$

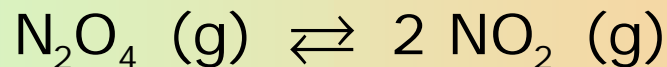
Exercises: Kc

Exercise #06

A 2 L-flask is charged with 0.10 mol of N_2O_4 and the equilibrium described below is reached. At this temperature the equilibrium constant is 0.58 mol/L. Determine the concentrations at equilibrium.



The # of moles and concentrations at equilibrium:



n initial	0.1	0
n changes	-x	2x
n equilibrium	0.1-x	2x
[] equilibrium	(0.1-x)/2	x

The equilibrium constant is:
$$K_C = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{2x^2}{0.1 - x} = 0.58$$

The value of x has to be between 0 and 0.1:
$$2x^2 + 0.58x - 0.058 = 0 \rightarrow x = 0.07875$$

The concentrations are:

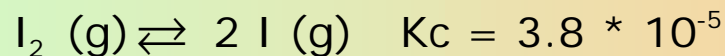
$$[\text{NO}_2] = x = 0.07875 \text{ M}$$

$$[\text{N}_2\text{O}_4] = \frac{0.1 - x}{2} = 0.010625 \text{ M}$$

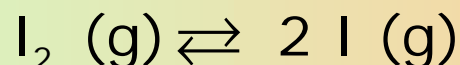
Exercises: Kc

Exercise #07

A 2.3 L-container is initially charged with 0.0456 mol I₂. Determine the concentrations of both components at equilibrium if temperature is kept constant.



The # of moles and concentrations at equilibrium:



n initial	0.0456	0
n changes	-x	2x
n equilibrium	0.0456-x	2x
[] equilibrium	(0.0456-x)/2.3	0.87 x

From the equilibrium constant:

$$K_c = \frac{[\text{I}]^2}{[\text{I}_2]} = \frac{2.3 * (0.87 x)^2}{0.0456 - x} = 3.8 * 10^{-5}$$

$$\rightarrow 1.74 x^2 + 3.8 * 10^{-5} x - 1.73 * 10^{-6} = 0 \rightarrow x \approx 0.001$$

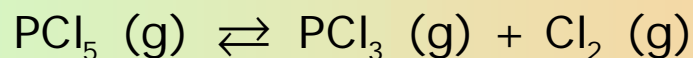
$$[\text{I}] = 0.87 x = 8.7 * 10^{-4} \text{ M}$$

$$[\text{I}_2] = \frac{0.0456 - x}{2.3} = 1.94 * 10^{-2} \text{ M}$$

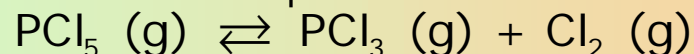
Exercises: Kc

Exercise #08

At a certain temperature, the equilibrium constant K_c for the reaction below is 0.00793 mol/L. Determine the percentage of decomposition of PCl_5 at the same temperature if a 1 L-flask is charged initially 3.13 mol of PCl_5 .



The # of moles and concentrations at equilibrium:



n initial	3.13	0	0
n changes	-x	x	x
n equilibrium	3.13-x	x	x
[] equilibrium	3.13-x	x	x

From the equilibrium constant:

$$K_c = \frac{[\text{Cl}_2] [\text{PCl}_3]}{[\text{PCl}_5]} = \frac{x^2}{3.13 - x} = 7.93 \cdot 10^{-3}$$

$$\rightarrow x^2 + 0.793 \cdot 10^{-2} x - 2.48 \cdot 10^{-2} = 0 \rightarrow x \approx 0.161$$

$$d (\%) = \frac{x}{3.13} * 100 = 5 \%$$